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Numerical analysis of an active dendrite (HH) using a compact difference scheme

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Dendrites are extensions to the neuronal cell body in the brain which are posited in several functions ranging from electrical and chemical compartmentalization to coincident detection. Dendrites vary across cell types but one common feature they share is a branched structure. Passive dendrites do not contain voltage sensitive ion channels thus voltage varies linearly with time. Active dendrites on the other hand have voltage sensitive ion channels which bring about a nonlinearity in the change of voltage with respect to time in these dendrites [1]. The Hodgkin Huxley equations describe the change in voltage with respect to time in an active dendrite. A solution to these equations is normally found using the finite difference scheme [2,3]. Spectral methods have also been used to solve these equations with better accuracy [4]. Here we report the solutions to these equations using the compact difference scheme which gives spectral like resolution but can be more easily used with modifications to the HH equations like nonlinearity, branching and other morphological transforms[5].Widely used in the study of turbulent flow and wave propagation, this is the first time it is being used to study conduction in the brain. Here we discuss its usage in a soma dendrite construct with cylindrical geometry. Different dendritic distributions of voltage gated ion channels are considered. The superior resolving power of the scheme compared to the central difference scheme becomes apparent with increasing complexity of the model.

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